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| **Lesson Title:**  **VIVID VOLUME**  **Volume Measurement of Common Geometric Solids** |
| **Subject area / course / grade level:**  **Geometry & Measurement / Math / Grades 5** |
| **Introduction:**  This lesson is designed to focus on a major content topic in the measurement curriculum – understanding how volume formulas are derived for common geometric solids, like prisms, pyramids, cylinders, and cones. Elementary students generally encounter solids very early on and study these shapes throughout their school grades. In particular, they are frequently introduced to common measurement formulas by mere presentation and often have to resort to memorizing them without fully understanding the general patterns supporting the formulas’ development. Memorization alone rarely allows for easy use or application of the measurement formulas within varied problem solving contexts. Thus, because students’ constructive knowledge of how these formulas are derived is limited, their ability to apply and/or recall the formulas may be limited as well. |
| **Lesson Length:**  **60 min** |
| **Materials:**    **Allow students to work in small groups (2 – 4 students). Each group needs:**   * Set of clear geometric solids – including various prisms and pyramids– with removable faces * Bag of dry rice per small group * Handout of Sample Exercises * Math Notebooks * Paper and pencils * Calculator * Butcher paper (for excess rice and easy clean-up in each group) |
| **Lesson Overview:**  (Per teacher directions and grouping):  Students should begin this lesson by sorting the geometric solids into like (size/shape) categories (prisms, pyramids, cylinders, and cones). Brief discussion should occur as to when students encounter these type shapes in real-life settings (e.g., buildings, cereal boxes, coke cans). The students will complete a graffiti wall to review what a prism pyramid, cylinder, and cone are. Also, students can brainstorm various objects which we see and/or use every day demonstrating the concept of volume. Groups should record their data and then focus on two major comparisons that will form the major parts of the Lesson:  **Compare the Prism and the Pyramid**   * Have students select a prism and a pyramid which have the **same size base and same height** (This is a critical requirement for the two shapes; otherwise the students will be comparing “apples & oranges” and the volume relationship between the two shapes will not be visible). * Present the question: *How many pyramid cups of rice are needed to fill a prism exactly?* Have students pose various estimates. Briefly discuss. (Expect responses like 2, 2½, 3, …) * Demonstrate in front of the class the number of pyramids it takes to fill the prism. Be as exact as possible; fill the prism one pyramid cup at a time to the notched edge. It should take exactly 3 pyramid cups to fill the prism given the shapes have the **same size base and same height**. Let students do the same as the teacher in their groups. * Discuss with students the results. After all reach agreement, have them complete the sentence:   *It takes \_\_\_\_ pyramid cups to fill the prism.* Allow students to reflect on their estimations compared to the actual number, and record their data/conclusions.  *Let the groups do this with 2 to 3 other prisms/pyramids.*  Shift to discuss the volume of the prism, **V=*lwh***  (Demonstrating the volume of the prism can be done in a variety of ways. Consider this example: use multi-link cubes and stack layers on top of each other creating a prism. See that volume is determined by multiplying the area of each layer (***lw***) by the number of layers in the stack (***h***).)   * Given the previous rice-filling demonstration, have students determine the volume of the pyramid, **V=*lwh*.**   That is, because it took 3 pyramids cups to completely fill the prism, the volume of the pyramid is then one-third that of the prism – again, given that the two shapes share the same size base and same height.   * **See Sample Practice Exercises:** * Debrief with students what they learned by having them write a brief summary on the board using results from the demonstration and their group work. Encourage students to use appropriate vocabulary. Add new vocabulary and formulas to a word wall. |
| **Tennessee Standards:**  GLE 0506.4.2 – Describe polyhedral solids and analyze their properties, including volume and surface area.    **MCS/Math Power Standards:**  Grade 5 - Find the area, volume and surface area of geometric figures including irregular shapes, prisms and  polyhedral solids. |
| **Lesson objective(s):**  **TLW:** Demonstrate appropriate understanding of vocabulary terms used to calculate volume.  Develop and apply content knowledge of how volume formulas are derived for common 3-D geometric shapes. |
| **ENGAGEMENT**  **Activity:**  Give each group a box of Animal Crackers, popcorn or etc.  Prompt a discussion based on questions like: *What can we do with this box mathematically?* *What shape is the box? How do you calculate the volume of the box?* Etc.  Listen/read along to the song “Pump up the Volume”  http://www.educationalrap.com/song/pump-up-the-volume.html  **More Questions**:  1. What is the Volume of the box?  2. How is calculating volume used in real-life settings?  3. Why is understanding how to calculate volume important? |
| **EXPLORATION**  **Hands-on/Minds-on Activities:**    *Refer to Lesson Overview for Activities.*  **Big-Idea Questions include:**  What are the formulas for calculating volume?  How is calculating volume used in real-life settings?  Why is understanding how to calculate volume important? |
| **EXPLANATION**  **Questions:**  How is calculating volume used in real-life settings?  Why is understanding how to calculate volume important?  How would you explain the formulas to a classmate and/or family member? Try it. |
| **ELABORATION**  **Watch this video on the volume of a pyramid.** [**http://www.mathexpression.com/volume-of-a-pyramid.html**](http://www.mathexpression.com/volume-of-a-pyramid.html)  **Additional Option:**  Teacher may choose to share *The Volume Video* to reinforce/enhance students’ knowledge. See website for  info: <http://www.havefunteaching.com/educational-videos/math/volume-video>   * Have students choose an object in classroom/at home which he/she will apply one of the formulas. * Reflect on all the different aspects of the formula and explain your findings to a classmate or your family.   **Vocabulary:**  polygons, volume, symbol, pi, rectangular prism, dimension, pyramid, prism, cone, cylinder, cubic units, capacity, compare, composite shape, calculate |
| **EVALUATION**   * Sample exercises * Teacher/student observations * On-going discussions * Students’ recorded data in their math journals |

**Pump Up the Volume**

**Chorus**

Pump up the volume, pump up the classroom

 Everybody’s sucking up skills like a vacuum

How big is the sun? How big is the moon?

Come on everybody let me here you pump up the volume

We’ve got three dimensions that we’re dealing with

Everybody feeling this? ‘Cause you know it’s not a myth

That we’re leaving flat shapes behind

Now we’ve got cubes and cones and cylinders on our mind full time

**Verse I**

When you’re measuring a cube you can’t measure it wrong

‘Cause every single little side of it is equally long

So to calculate the volume it’s pretty simple, you see?

Take any side of it and raise it to the power of three

A rectangular prism is just a little bit harder

We’re gonna stretch your knowledge of it just a little bit farther

First you wanna check the angles are right (90º)

And then you multiply the length times the width times the height

**Chorus**

**Verse II**

Next is the cylinder, but don’t be scared

It’s just the height times π times the radius squared

 For the Volume of a cone, division is key

You take the height times πr² but then divide it by 3

Last but not least we’ll examine a sphere

 Like the sun or the moon or the bubbles in your root beer

 After our research, we must conclude

That it’s 4∕3 × πr³